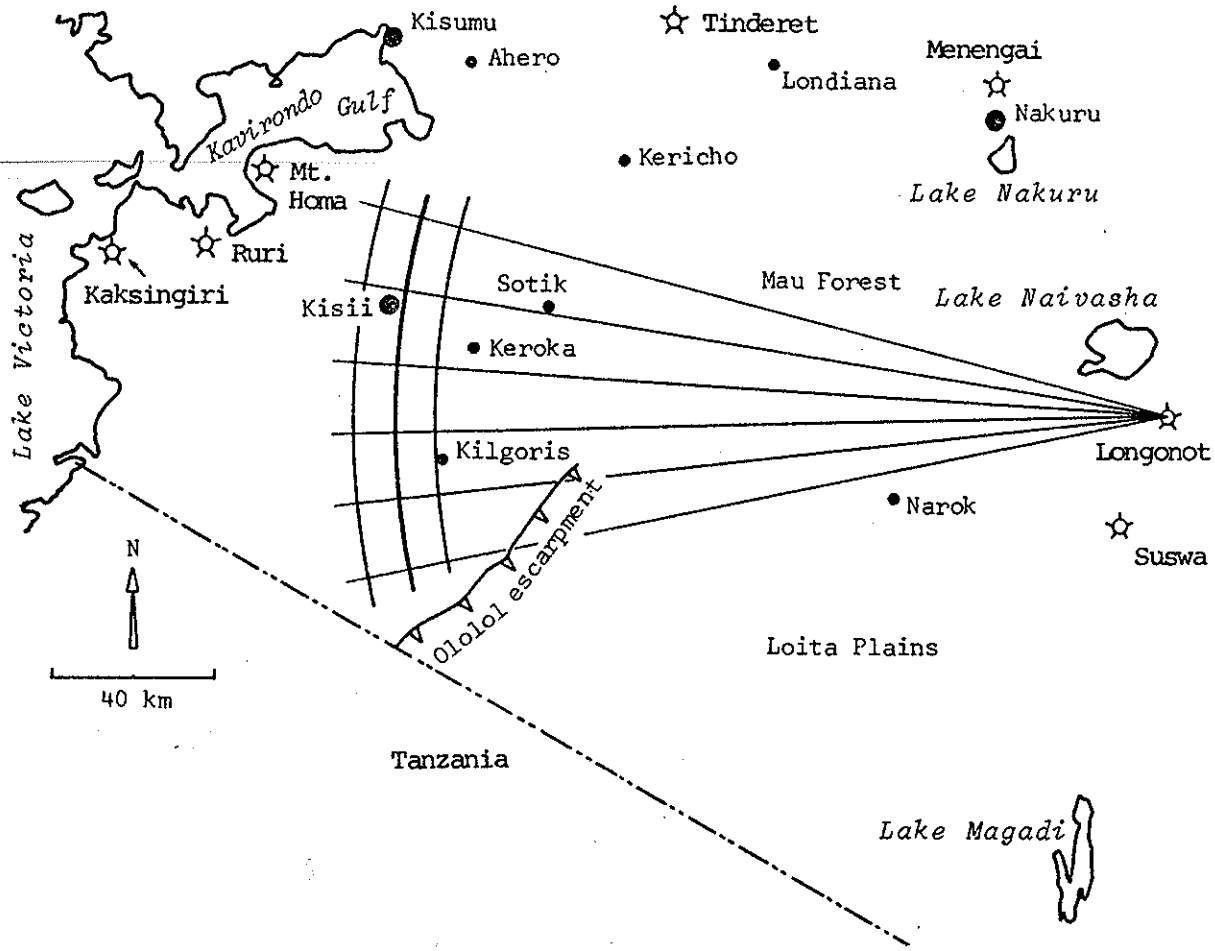
# TRAINING PROJECT IN PEDOLOGY

# KISII KENYA




## Soil formation in the Kisii Area and the role of volcanic ash

PRELIMINARY REPORT NO 5

AGRICULTURAL UNIVERSITY

WAGENINGEN - THE NETHERLANDS

# Soil formation in the Kisii Area and the role of volcanic ash

by

W.G. Wielemaker

Preliminary Report no. 5

August 1979

TRAINING PROJECT IN PEDOLOGY, KISII, KENYA

Agricultural University, Wageningen - The Netherlands

Contents


| | |
|---|---|
| Preface | 2 |
| Participants | 3 |
| Abstract | 3 |
| Introduction | 4 |
| Surfaces and parent material | 4 |
| Source and distribution of volcanic ash | 7 |
| Dating of younger ashes | 11 |
| Biogenetic and colluvial soil forming processes | 11 |

Preface

This report of the Training Project in Pedology at Kisii of the section on Tropical Soil Science of the Agricultural University at Wageningen, the Netherlands is the fifth one of a series to be presented to Kenyan officials.
The project started in November 1973 after assent had been granted by the Office of the President of Kenya, and finished, as far as field work concerns, in April 1979.
It was meant for training of postgraduate students of the Agricultural University at Wageningen and for furnishing research opportunities to the staff. The activities of students and staff were directed to obtaining a better knowledge of the soils and the agricultural conditions of the project area to provide a basis for the further agricultural development of the area.
The project in Kisii was conducted by:
Ir. W.G. Wielemaker, teaching and research
Ing. H.W. Boxem, management.
Visiting specialists from the Agricultural University at Wageningen helped to resolve special problems.
This report is written by the former teamleader Ir. W.G. Wielemaker and has also been presented to the Third Annual General Meeting of the Soil Science Society of East Africa of July 1979.
We hope to pay back with these reports a small part of the great debt we owe to Kenya in general and to many Kenyans in particular for their valuable contributions to the good functioning of the project.

The supervisor of the project

J. Bennema, Professor of Tropical Soil Science

# Soil formation in the Kisii Area and the role of volcanic ash

by W.G. Wielemaker

A contribution of the department of Soil Science and Geology of the Agricultural University at Wageningen, the Netherlands, to the third annual general meeting of the Soil Science Society of East Africa, held in July 1979 in Nairobi.

Participants in this research:

Department of Soil Science and Geology: Prof. J. Bennema (Supervisor), Prof. J.D. de Jong (geomorphology), Dr. L. van der Plas (mineralogy), Dr. S. Slager (thin sections).

Postgraduate students : P.N. Boerma, G.R. Hennemann, R.F. Breimer, J.H.M. Scholten, A.P. Oosterom, H. van Reuler, E.M.G.C.A. Duykers, C.H.M. Duykers-van der Linden, P.A. van der Werff, E.W. Elsas, J. Hayma, G.J. van Dijk, K. Muilwijk, Miss E. van Lint.

Cooperation and aid with analysis: National Agricultural Laboratories, Department of Geology and Mines (Nairobi), Laboratory at Kisii, C-14 analyses at the physics laboratory of the University at Groningen, the Netherlands.

Abstract

Part of the work in Kenya, done by the Agricultural University of Wageningen, the Netherlands, dealt with the role of volcanic ash in the soils of South-Western Kenya, particularly the Kisii-area. The paper discusses the influence of ash on soil characteristics and fertility, the biogenetic and colluvial processes responsible for incorporation of the ashes in the soils and the source and age of the ashes.

## Introduction

The studies were conducted in the South-Western part of Kenya during the period 1973 to 1979 as part of a soil training and research program of the department of soil science and geology of the Agricultural University at Wageningen, the Netherlands. The program closely coöperated with the Kenya Soil Survey, especially for the preparation of a reconnaissance soil map and adjoining report. A series of preliminary reports gives the results of surveys and part of the research. Research with respect to the role of volcanic ash in the soils of Kisii will be published later by the author. This paper highlights only the most important results. The short time available doesn't allow us to go into any detail.

## Surfaces and parent material

The present topography was formed as a result of the successive upwarping and incision of formed planation surfaces. The whole sequence of planation surfaces can still be recognized. (see fig.1). The oldest one, or Kisii surface, which occupies the summit levels of the Kisii-highlands, is supposed to date back to the Jura. The rather flat remnants still exist thanks to the protection of the resistant quartzites. The younger surfaces were dated as:

End Cretaceous to Early Tertiary (Magombo surface)
End Tertiary (Chepalungu surface)
Mid Pleistocene (Magena surface)

No relation of soils with surfaces was discovered.
A relation with the underlying consolidated rock is only partly existing in West Kisii. Considering the differences in composition of the underlying hard rocks, soils are surprisingly uniform, the clay percentage is over 60 percent, the iron content over 10 and the weatherable mineral content is not very divergent. (see fig. 2).

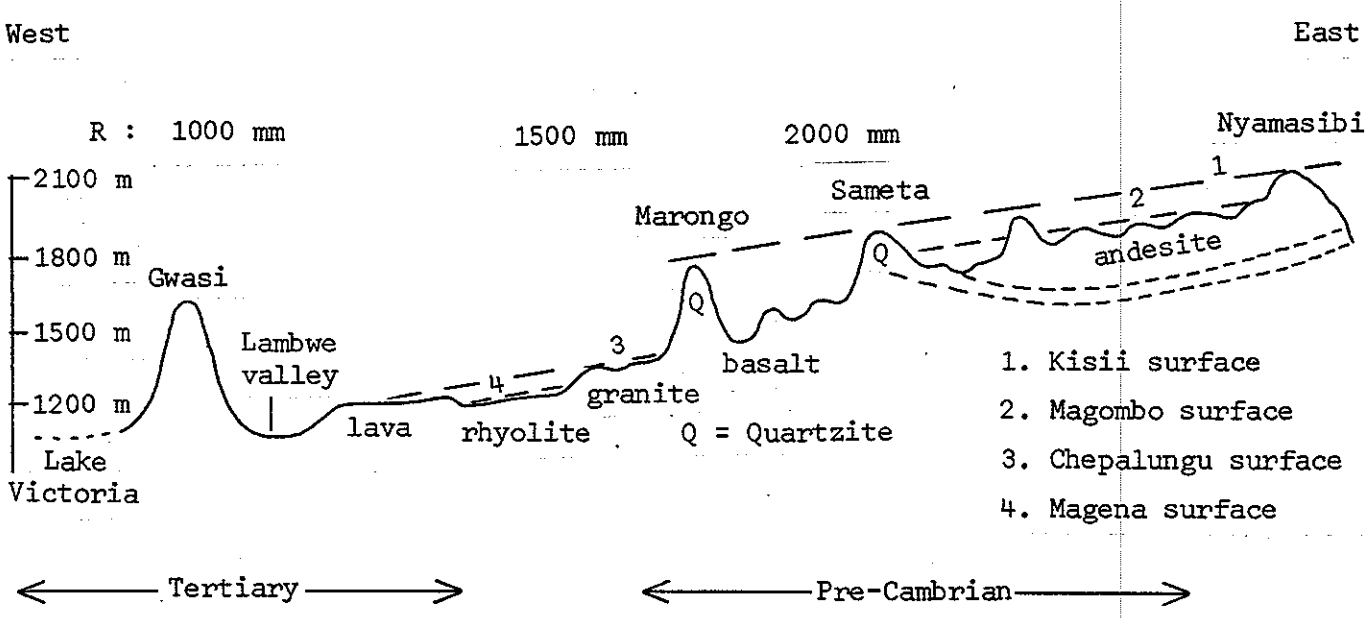



Fig. 1 Cross-section through Kisii and Sout Nyanza and location of planation surfaces.

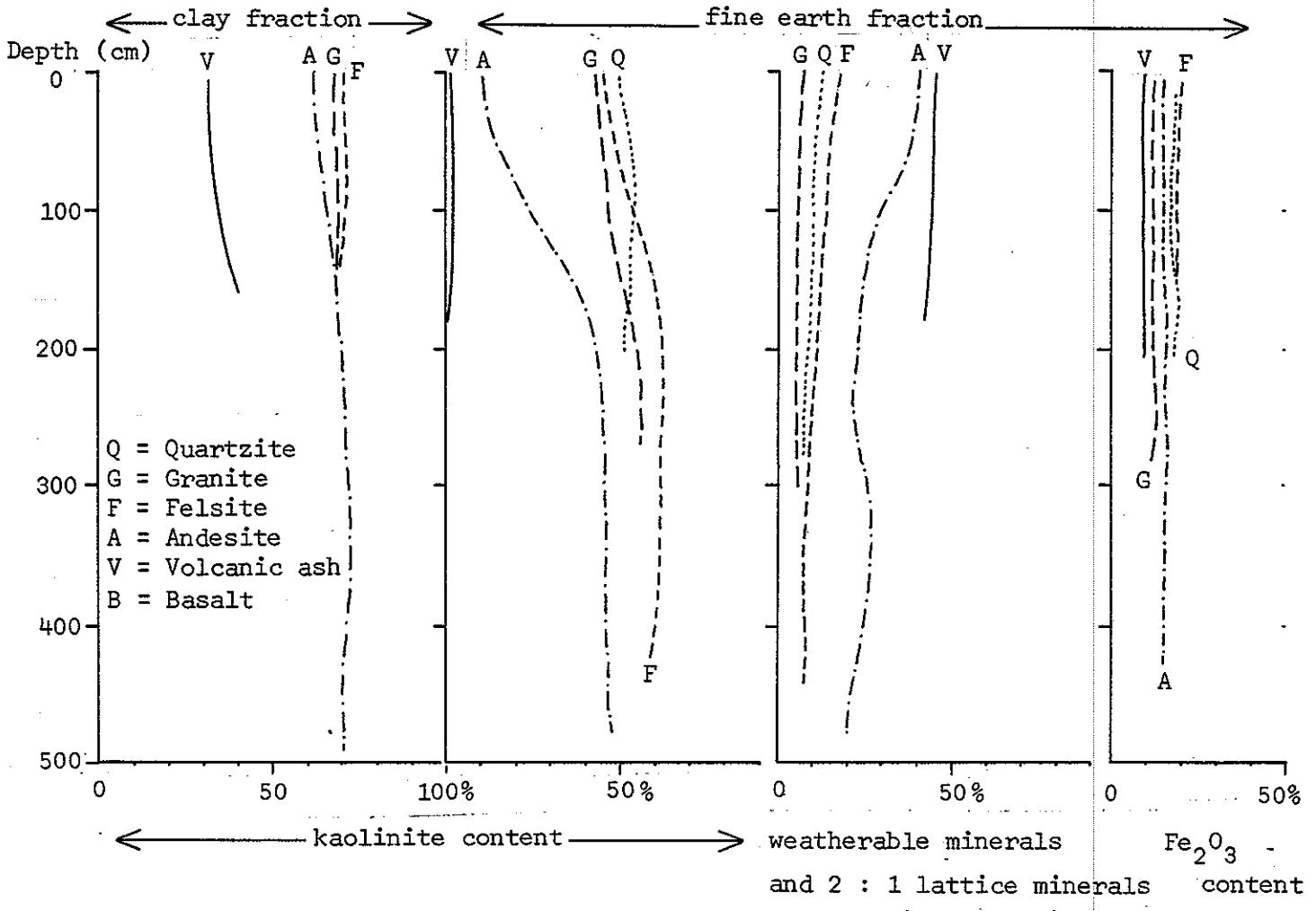



Fig. 2 Relation between mineral composition and depth for soils on various parent materials, according to norm calculations.

Only the base saturation is related with the underlying rock, especially in the topsoils; it is low for quartzite soils, somewhat higher for granite soils and highest for basalt and felsite soils (see fig.3).

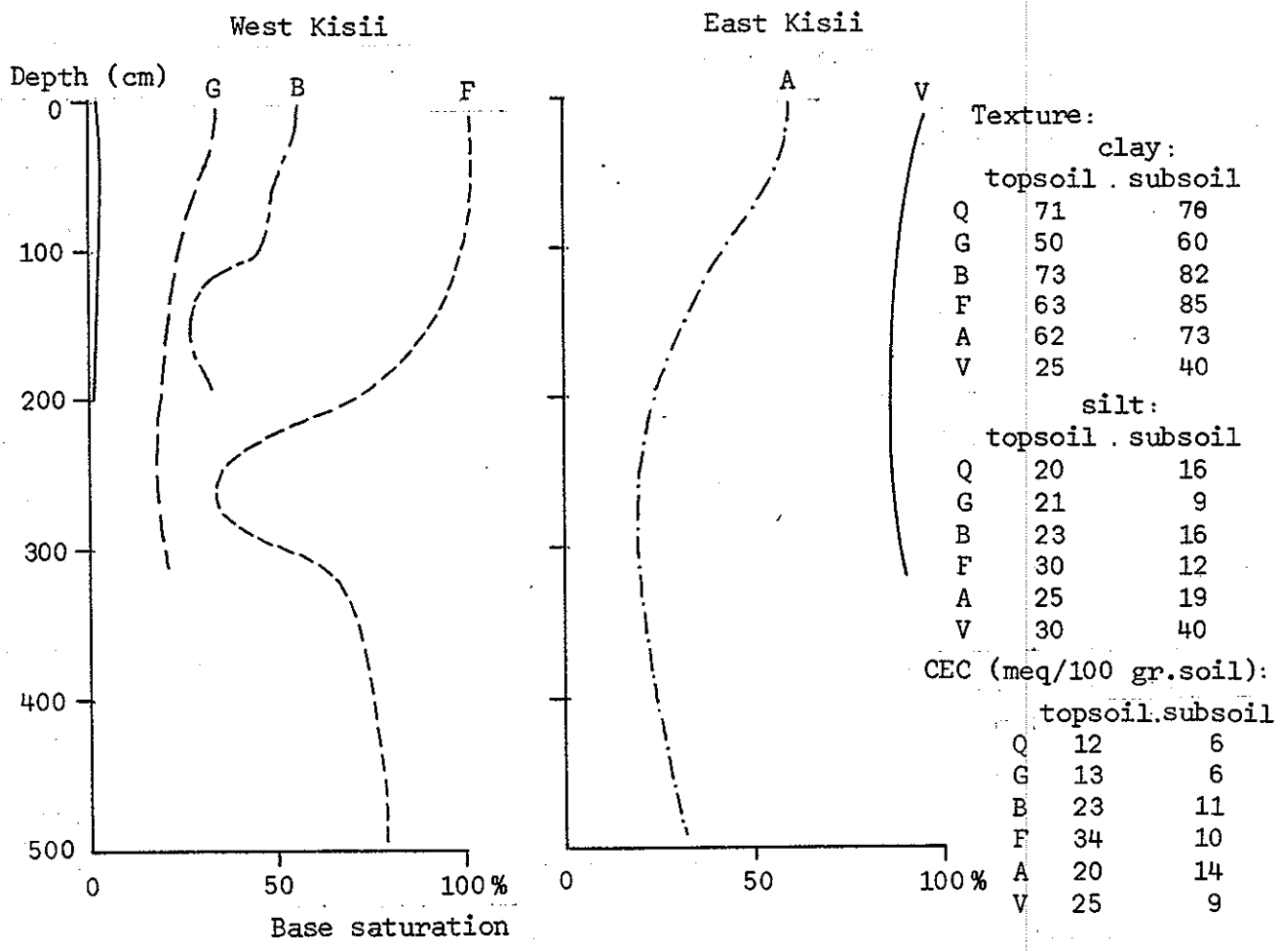



fig. 3 Relation between base saturation and depth for soils on various parent materials

Also the rather coarse quartz grains, occurring throughout the soils on granite, are related with the underlying rock.

The soils in East Kisii have a higher base saturation and a higher weatherable mineral content throughout the profile, while the clay percentage is rather low. Those soils developed from volcanic ash. The soils over andesite are located in the area between East and West Kisii. They have a weatherable mineral and kaolinite content intermediate between East and West Kisii soil.

A considerable volcanic ash influence in the soils of Kisii is the only possible explanation for the uniformity in characteristics of the soils in West-Kisii. The difference between the East and West Kisii soils is due to the amount of fresh ash brought by the more recent ash showers. It is assumed, that the influence of fresh ash becomes less from East to West Kisii. Its influence on the fertility of the soils in West-Kisii is therefore only noticeable in the topsoils. Volcanic glass is however found in many soils from West-Ksiii also in deeper layers, which proves that ash showers influenced that area during a long period.

Source and distribution of volcanic ash.
Volcanic ash materials as well as soils were sampled and described in the area covered by figure 4.

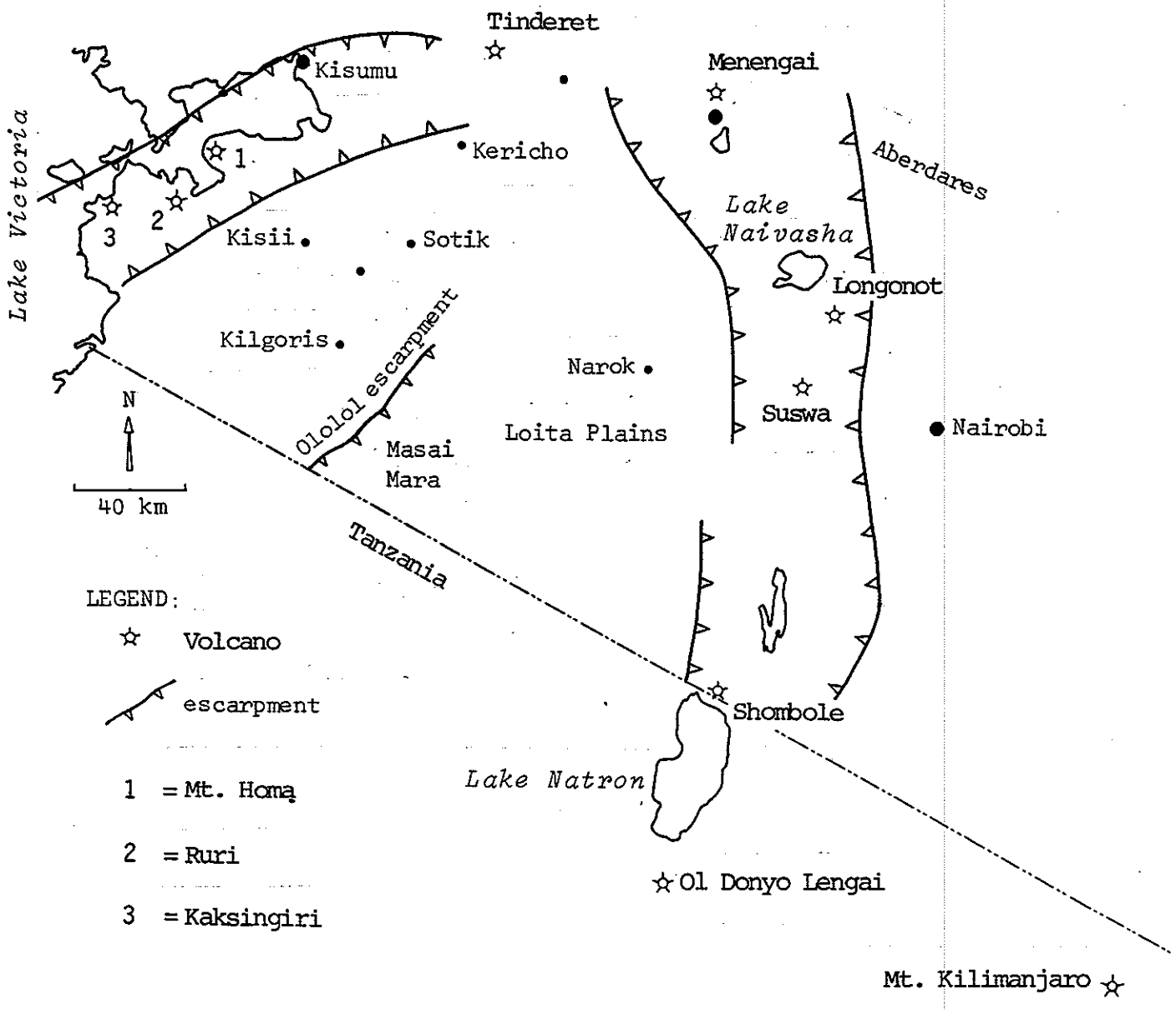



Fig. 4 Location of the volcanoes.

Fig. 5, 6 and 7 show us the results of chemical and textural analyses. The distribution pattern gives the best fit relation if we assume Longonot to be the source of the ashes.

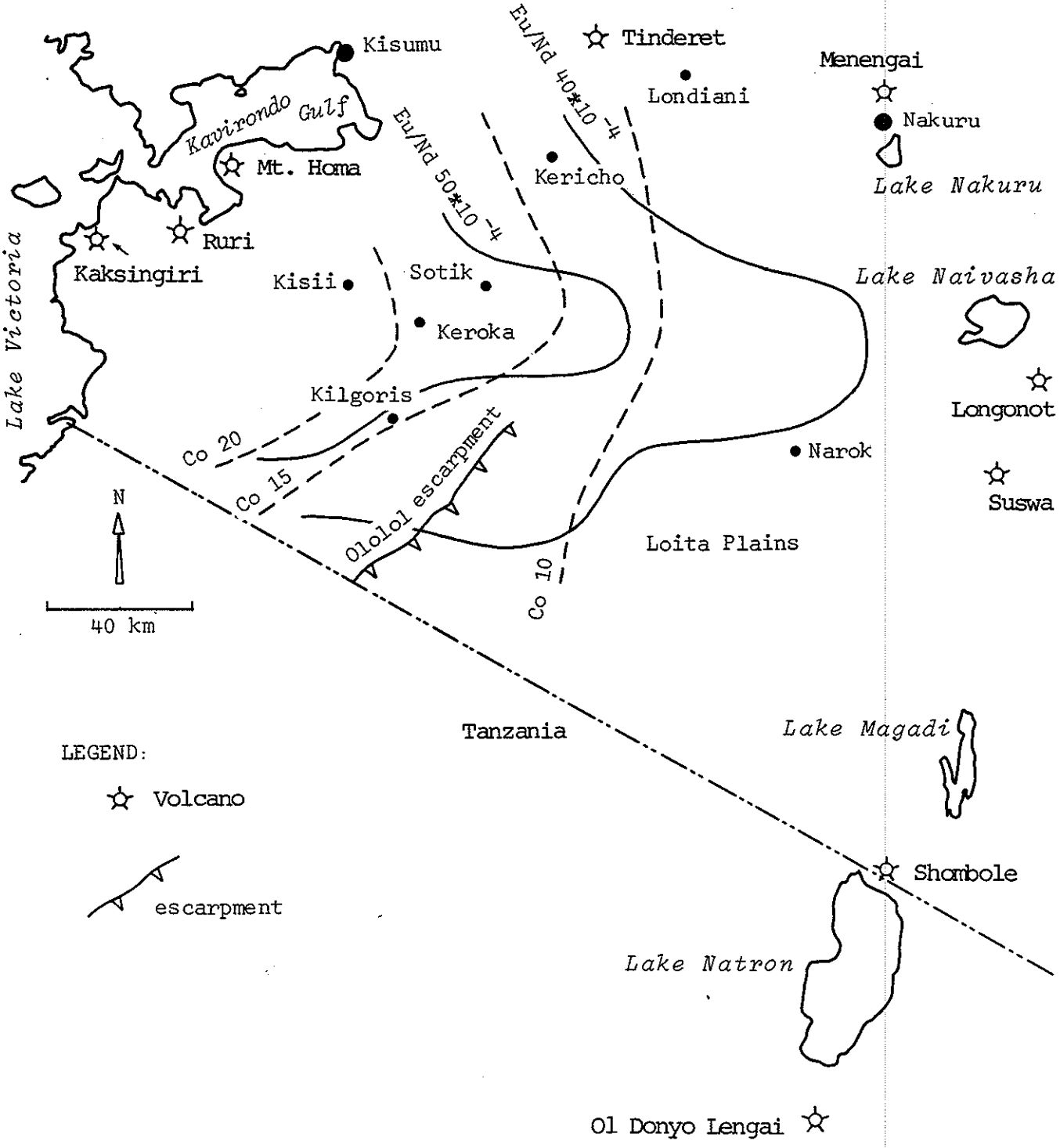



Fig. 5 The Europium/Nyodibium ratio, the Cobalt content(ppm) of soils and the volcanic ash origin.

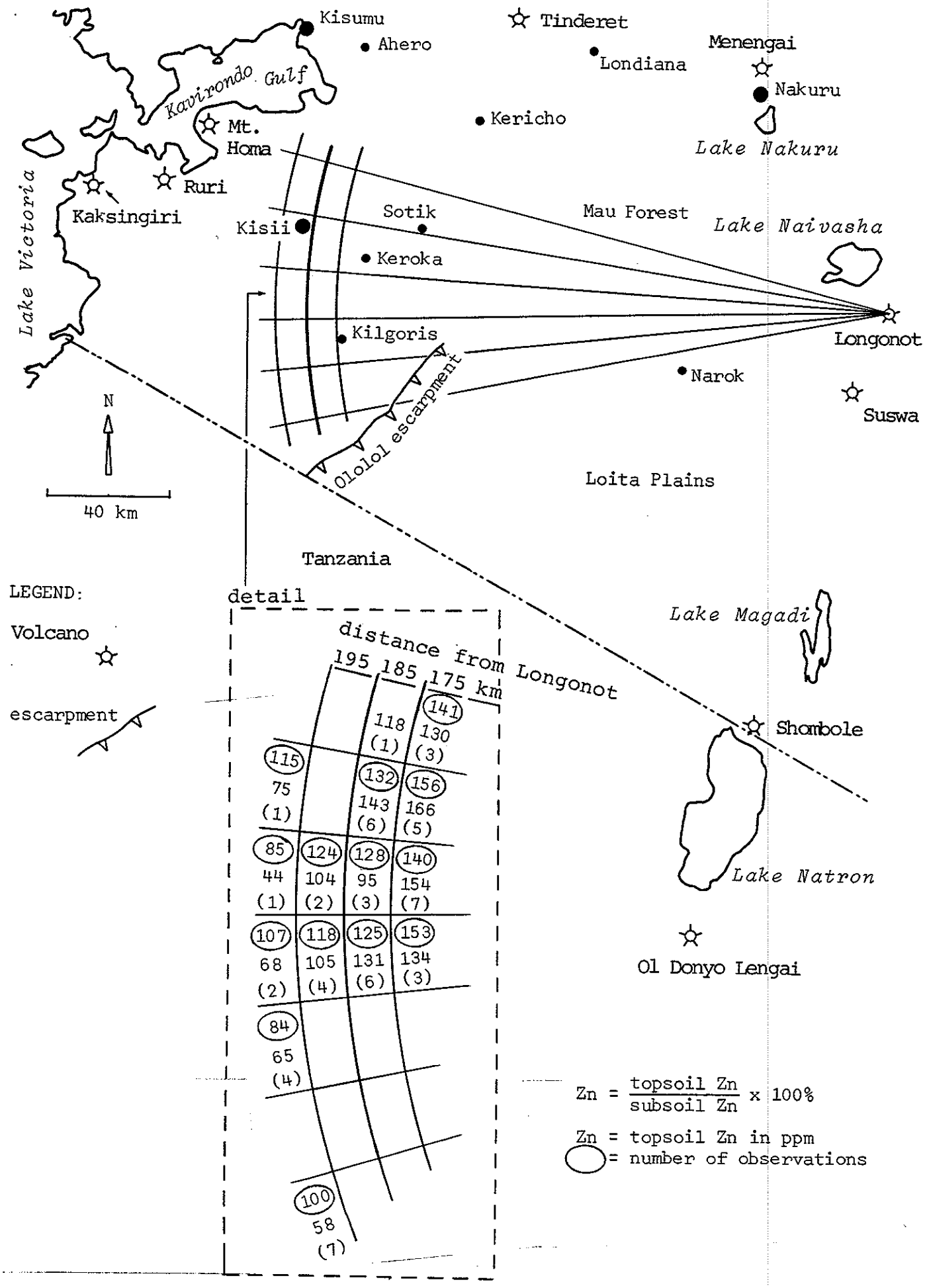



Fig. 6 Relation between zinc content of the soils and distance to the Longonot volcano.

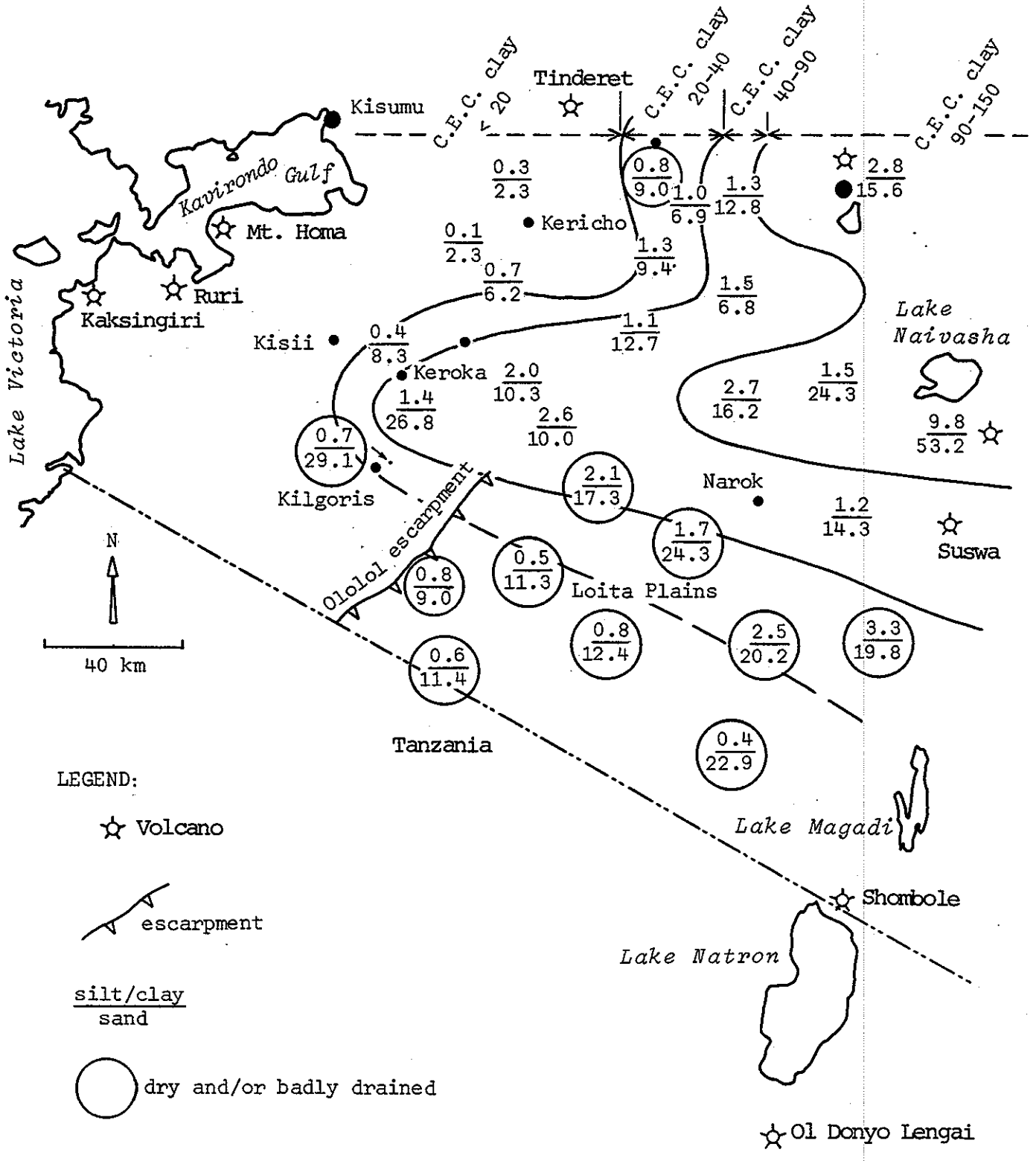



Fig. 7 Silt/clay ratio and sand percentage in the soil in relation to the origin of the volcanic ashes.

The highest silt/clay ratio and sand percentage correspond with the centre of the windblown cone of ashes. Colour of the soils and CEC-clay are related with it. The prevailing wind was clearly East.

Dating of the younger ashes

Well preserved 4-5 meter thick ashbeds are found throughout western Kenya in flat bottomed valleys. The ashes are remarkably pure and show little alluvial admixtures. The streamprofile of the river Gucha shows us the areas of ash-deposition (see fig. 8).

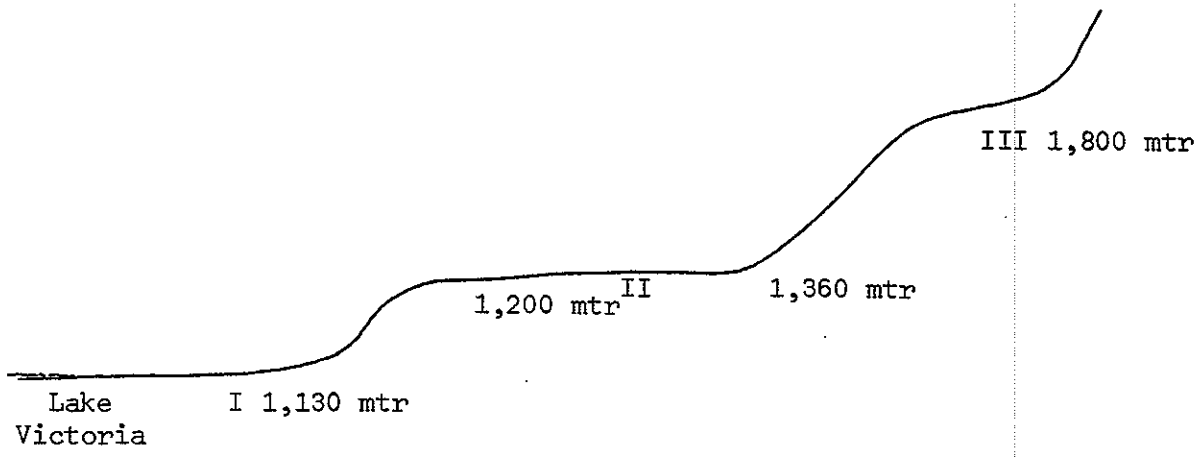



Fig. 8 Streamprofile of river Gucha and the occurrence of pure ashes

One can assume that ashes in the three positions are all of the same age. Artefacts were especially found in position II. Mr. Onyango Abuje of the archaeological museum at Nairobi, classified them as belonging to the Stillbay-Stone age culture; probably less than 100,000 years old.
A C-14 date at a depth of 3 meter from position III gave an age of 50,000 years.

Biogenetic and colluvial soil forming processes

In how far volcanic ash has influenced existing soils, is to a large degree dependent on topography, climate, vegetation and the distance and position with respect to the source of the ash. Steep slopes hold less ash than gentle ones, while a poor vegetation cover holds less ash than a well

developed vegetation. What happens to the ash, when deposited under well drained conditions?
The soil fauna (termites, ants, moles, antbears etc.) mixes ash with the existing soil. Termites dig to great depth and their activity is enormous. Relatively fine material (2 mm diameter depending on the mandible size) is transported upwards; coarse material cannot be transported and tends to sink in the soil. This process leads to the development of stonelines so well known in well drained tropical soils.
Slope transport (see fig. 9) helps to accumulate coarse and fine material of the steep slope, covered with shallow soils, on the footslope.

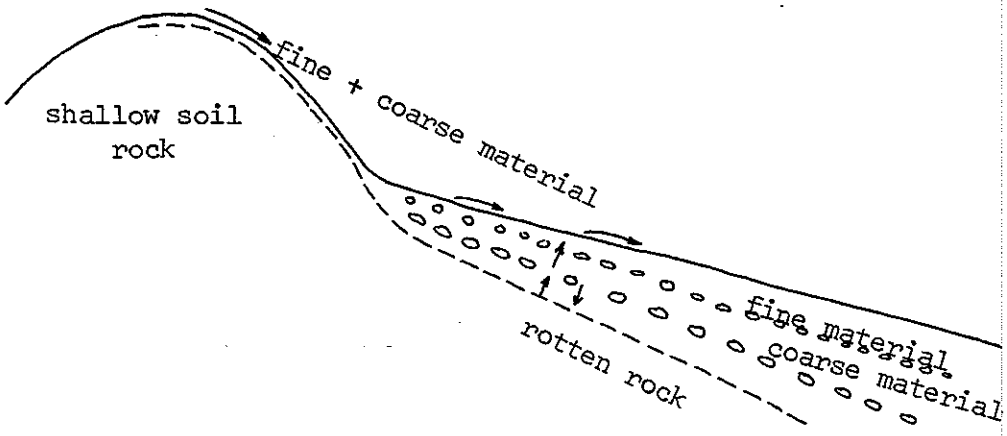



Fig. 9 Slope transport and biological activity

This material together with ash is mixed with the existing soil and rotten rock particles. Weathering of the ash further complicates the recognition of the ash materials in these well drained red soils.
It is obvious that the knowledge of these processes is important for an understanding and classification of the soils of Kisii. The ash influence on the fertility level of the soils and especially the topsoils is noticeable (fig. 2 and 3). Without the ash, Kisii would not be such a florishing highly productive agricultural area. Present intensive agricultural practices tend to mine this important resource. Maintenance of the fertility level of the topsoils is of paramount importance for the agriculture of Kisii district.